their own special studies. Men of science, we may be certain, are fully aware of the importance of the undertaking, which is indeed designed for their special benefit; and although they are a hard-worked race, I do not question that a sufficient number of volunteers would be forthcoming. When one looks, for example, at the immense labour of costly and unremunerated research undertaken by a man like the late Mr. Carrington, one cannot doubt that men will be found to undertake the humbler but scarcely less useful and infinitely less onerous task of making the discoveries of the Carringtons generally available. I am sure, for instance, that such men as Mr. Knobel and Mr. Carruthers would most readily undertake the classification of the astronomical and the botanical departments respectively, provided that their other engagements allowed, as to which, of course, I cannot affirm anything. Supposing our scientific editors found, they would proceed exactly in the same manner as the editor who had already accomplished the classification in the rough. Each would take the cards belonging to his own section, and would write opposite to the general subject title written by the first classifier the heading of the minor sub-section to which he thought it ought to be referred; thus, opposite Botany—Lichen, and so on. He would then put the title into the box or drawer belonging to its sub-section, and when the work was complete we should have the whole catalogue in a classified form, digested under a number of sub-headings. Some preliminary concert among the scientific editors would, no doubt, be necessary, and a final revision in conformity with settled rules. It might be questioned, for example, whether a dissertation on camphor properly belonged to botany, chemistry, or materia medica; whether the subject of the gymnotus was ichthyological, anatomical, or electrical; whether in such dubious cases a paper should be entered more than once. It would save time and trouble if these points could be determined before the classification in the rough was commenced; in any case considerable delay from unavoidable causes must be anticipated. It is to be remembered, on the other hand, that the work could, under no circumstances, be completed until the publication of the Royal Society's alphabetical index of papers from 1865 to 1873 was finished, which, I suppose, will not be the case for two or three years. There will, therefore, be sufficient time to meet unforeseen causes of delay. If the classified index could be ready shortly after the alphabetical, if we could show the world that the work was not merely talked about as desirable, but actually done in so far as depended upon ourselves and the representatives of science; that it already existed in the shape of a card catalogue, and needed nothing but money to be made accessible to everybody—then we should be in a very different position from that which we occupy at present. I cannot think that so much good work would be allowed to be lost. The catalogue, not being confined to papers in the English language, would be equally useful in every country where science is cultivated, and would find support all over the civilised world. Either from the Government, or from learned societies, or the universities, or the enterprise of publishers, or the interest of individual subscribers, or private munificence, means would, sooner or later, be forthcoming to bring the work out, and thus erect a most substantial monument to the utility of our Association. It would obviously be important to provide that scientific papers should be indexed not only for the past, but for the future. If, as I trust, the Royal Society intends to continue the publication of its alphabetical index from time to time, the compilers of the classified index will continue to enjoy the same facilities as at present. There must be some very effectual machinery at the Society for registering new scientific papers as they are published. What it is we may hope to learn from our colleague, its eminent librarian, who must be the most competent of all authorities on the subject. Mr. Bailey draws attention to several scientific periodicals as useful for bibliographical purposes, and I may mention one which seems to be very complete.[1] It is published at Rome. The number for last December, which I have just seen, is so complete that, among a very great number of scientific papers from all quarters, it records those on the telephone and the electric light, in the "Companion to the British Almanac," which, I think, had then been only announced here, not published, omitting the other contributions as non-scientific. It further gives a complete index to the contents of the *Revista Cientifica*, a Barcelona periodical, which had apparently just reached the editor, from its commencement in the preceding April. By this list I learn that the electric pen, the subject of our colleague Mr. Frost's recent paper, had been the theme of a communication to a Barcelona society in May last. It certainly seems as if any library that took this periodical in, and transcribed the entries in its bibliographical section on cards properly classed, would be able to keep up a pretty fair subject-index to scientific papers for the future. I must, in conclusion, say a few words on a subject-index to the transactions of literary societies. The prospect is here much more remote, from the want of the almost indispensable ground-work of a general alphabetical index. We have seen what an infinity of trouble in collecting, in cataloguing, and in transcribing will be saved by the Royal Society's list in the case of scientific papers, and are in a position to appreciate the impediments which must arise from the want of one in this instance. The work could be done by the British Museum if it had a proportionate addition to its staff, or by a continuance of the disinterested efforts which are now devoted to the continuation of Mr. Poole's index to periodicals. Failing these, the most practical suggestion appears to me Mr. Bailey's, that the undertaking might be to a considerable extent promoted by the respective societies themselves. If the secretaries of the more important of these bodies would cause the titles of the papers occurring in their transactions to be transcribed upon cards and deposited with this Association, we should accumulate a mass of material worth working upon, and which might be arranged while awaiting a favourable opportunitity for publication. In some instances even more might be done. The library of the Royal Asiatic Society, for example, contains not merely its own transactions, but those of every important society devoted to Oriental studies, as well as all similar periodicals. Our friend, Mr. Vaux, could probably, in process of time, not only procure transcripts of the papers contained in these collections, but could induce competent Orientalists to prepare a scheme of classification, and such a classified list, complete in itself and of no unwieldy magnitude, could be published as a sample and forerunner of the rest. The initiative in such proposals, as well as those referring to scientific papers, should be taken by our Association, which can negotiate with eminent men and learned bodies upon equal terms, and speak with effect where the voice of an individual would be lost. The desideratum of a classed index, in a word, affords our Society a great opportunity of distinguishing itself. It is this aspect of the matter, no less than the importance of the matter itself that has encouraged me to bring it under your notice.

ON VARIABLE STARS

IT had long been known that certain stars greatly varied in brightness and some observations had been made concerning them, but it was reserved to the Herschels to pave the way for practical investigators. Notwithstanding the importance of the results which the observation of them bids fair to offer concerning the nature of the sidereal universe, the variable stars have not attracted so much attention as other even less important phenomena in the starry heavens, and one cause of this must be sought in the circumstance, that most of these observations are best made with very small telescopes or even with the naked eye, and while it is the duty of the professional astronomer to make use of the expensive instruments, of which he has charge, the inclination of the amateur astronomer in this country often leads him in the same direction. However, the attention of those who take an interest in the science but cannot afford a large outlay, cannot too often be urged towards this kind of observation, that while it so much needs their help is so thoroughly within their reach.

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[1] *Bullettino di bibliografia e di storia delle scienze matematiche e fisiche.* Pubbl. da B. Boncompagni; Rome, 1868, &c.

The best method is due to Argelander, a follower of Bessel, who was considered the first authority on the subject during his lifetime. It was propounded in his "Aufforderung an Freunde der Astronomie zur Anstellung von eben so interessanten und nützlichen, als leicht auszuführenden Beobachtungen über mehrere wichtige Zweige der Himmelskunde," which appeared in Schumacher's *Jahrbuch für* 1844, a periodical seldom met with in this country, which may in a measure explain the comparatively little attention that has been given to this subject on the part of British amateurs, who have so energetically followed up more complicated investigations. The success of those who have spent even a short time on these observations may be considered a sufficient appeal, and we venture to hope that the following short sketch of the easiest and most convenient method will be acceptable to some of the readers of NATURE who have not Argelander's lengthy paper at hand. The observations are in reality far simpler than the description of them looks. The stars visible to the naked eye are arranged in six classes according to their brightness, but it is often doubtful to what magnitude we shall refer an object, because we are able to judge about much smaller differences than those that distinguish two magnitudes, the number of which is therefore too small. The smallest difference perceptible to the average sight is a tenth of a magnitude, and we are therefore able, by a method of sequences, to reach a considerable accuracy. Researches on variables have further this advantage that we do not want to know the absolute magnitude but only the brightness relatively to certain other stars. These comparison-stars must be chosen with intervals of not above a half magnitude, and be situated as near the variable as they can be had, for the transparency of the air is often different not only in different altitudes, but also in different azimuths—nay even owing to aqueous vapour and chemical causes at times in the same place. Observations near the horizon should be avoided, and near the zenith the position is difficult. Twilight, moonlight, and lamplight would likewise interfere, and above all it must be avoided to observe from a lighted room. Against the moon or a distant gas-lamp in a town a screen can be used. If clouds are near they will render the comparisons uncertain. Cirro-stratus commencing to descend from high in the atmosphere is particularly deceiving. The estimation of stars of the first magnitude is difficult, and an evenly illuminated background in this case rather an advantage, or a slight fog, but in the latter case and when detached clouds are on the sky the observations have to be repeated with an interval of a few minutes, because fogs are rather irregular; at other times an observation may be secured in a few minutes, and more observations the same night are only required in case of quickly changing stars. They generally give identical results, but two or more observers are an advantage, though their estimations may have constant differences, because various colours affect individual eyes differently. No attempt need be made to look simultaneously at both stars, because the sensibility of the eye in different spots is different, and this error would not be eliminated. Look first at one star, then turn quickly to the other, look at that and return to the first again. It is well to turn the eye a little to the side, when watching a star. It appears then brighter, because the middle of the retina is tired with constant work. The comparison of stars barely visible is to be avoided. The results, together with the nature of the circumstances, should be noted at once, and in the dark. It will be remarked that the causes of error, referred to above, are not sensibly removed by using photometers, and other errors may be introduced by such complicated apparatus. Faint stars may be observed through a binocular. The glass used should be colourless, always the same, and the distance between the eye-glasses carefully adjusted. It must be confessed that this kind of work cannot be carried out in places where the sky does often not clear for months, as in North-West Ireland; on the other hand the English climate seems favourable. It is often blue sky, if only partly, and no superior definition is required. At present this part of astronomy is mainly dependent upon the labours of Julius Schmidt, of Athens. Some knowledge of the constellations is necessary, and that may be gained from Argelander's or Heis's Uranometries. In case the research be extended to telescopic stars Argelander's large atlas should be procured. It is known that Pogson at Hartwell and Madras has made diagrams of stars round the variables, which would be very useful.

The differences are noted in "steps," each of which is equal to a tenth of a magnitude. If the comparisons are doubtful but most give one star, a, larger than another, b, it is said that a is one step above b : $a\,1\,b$. If at all times a seems larger than b, it is two steps above it : $a\,2\,b$. If the difference is remarked at a glance, a is three steps above b : $a\,3\,b$. Still greater difference is denoted $a\,4\,b$, which is occasionally used, though so great a difference cannot be estimated so exactly as a smaller one, the probable error of which is much below one step, so that it is preferable to give the comparisons in half steps. For exercise Argelander's comparison stars can be used from "Astronomische Beobachtungen auf der Sternwarte zu Bonn," vol. vii., 1869. The steps might not be exactly identical in all cases, but they ought not to deviate much. The variable should not only be compared with the greater and smaller star but also with the mean of them, which is very accurate. From each comparison follows then the brightness of the variable, and the average of these is taken first in the common manner, next allowing weights inversely proportional to the number of steps, and the means of the two is assumed as the definitive result. Of course this is more estimated than computed, and the two results agree generally.

From magnitudes thus obtained in a scale of steps the epochs of maxima and minima are next sought, from which follows the period, which is the principal element. When a sufficient number of periods are available it can be seen whether this is constant, and if not, one must try to find a formula which will give the length at any time. A good many periods are about 300 days, but many only a few days. The brightness in the two principal phases will generally be found irregular if the period be so. Some stars have more than two maxima and minima during the same period. Next we project on a paper ruled in squares the brightness of the variable with the time as abscissa, counted from the nearest preceding maximum and expressed in parts of the respective period. The curve drawn as nearly as possible through the points, whose weights may be indicated by circles round them, is called the light curve, and on that we can read off the brightness for any moment, but it is not always possible to treat the observations thus *en masse*; sometimes single periods have to be separately discussed, and indeed when it is great we can arrive at some results from a single period, but if it is short many revolutions must be watched. These stars proceed more quickly from minimum to maximum than from maximum to minimum, and this is also the case with new stars. At last it is found that the colour is most monochromatic nearest the minimum. The brightness of the comparison stars is best obtained from their comparison with the variable and become therefore better known the more revolutions are watched. The final discussion will sometimes show that one or more of the comparison stars are variable themselves, for astronomers agree that there are many more variable stars in the sky than those contained in the catalogues.

As to the physical explanation of these phenomena we do not learn much from Argelander, who was one of the last champions of the old school. It is even said about him that he to the last stuck to Herschel's theory of the structure of the sun in spite of this being opposed to Newton's axioms, and framed, according to the now obsolete assumption, that every heavenly body ought somehow to furnish a comfortable abode for beings like ourselves. We can only comprehend unknown things from what is already known to us, and it is therefore rational to suppose variable stars analogous to our sun, whose lustre must vary with the extent of its spots. It is no doubt reserved to the spectroscope to settle the question, meantime we can only keep in view Hind's important remark that variable stars are often of a ruddy colour, and appear surrounded by nebulosity at their minimum. W. D.

COFFEE-LEAF DISEASE OF CEYLON AND SOUTHERN INDIA

1. *HISTORICAL REMARKS.*—During the last ten years, the coffee plantations of Ceylon and Southern India have had to contend with a disease which has seriously affected their productiveness and entailed a heavy loss upon the proprietors. This disease, *Hemileia vastatrix*, popularly known as the coffee-leaf disease, was first observed in May, 1869, on a few plants in Madulsima, a newly-opened coffee district in the south-west of Ceylon, bordering on the low country. In July following, two or three acres were attacked, and from that time the disease has gradually spread, till, in 1873 all, or nearly all, the estates in the island were attacked by it. On the appearance of the disease in 1869, the distinguished fungologist, the Rev. M. J. Berkeley, determined its true character, and described it in the *Gardener's Chronicle* for 1869 (p. 1,157, with woodcut). It was found to be a fungus allied to the moulds, and named *Hemileia vastatrix*, B. and Br. It was subsequently described in the *Journal* of the Linnean Society ("Botany," vol. xiv. p. 93, pl. 3, Fig. 10), and a short notice appeared in the *Quarterly Journal of Microscopical Science*, 1873, pp. 79–81. In 1876 Dr. M. C. Cooke described and figured the disease from Indian specimens in the India Museum Report, 1876, pp. 4-6. More recently the Rev. R. Abbay, who, during several years residence in Ceylon, made this disease an object of special study, gave a fuller description of it, with the results of his observations upon the germination of the spores and their growth under artificial cultivation, in the *Journal* of the Linnean Society, 1878 ("Botany," vol. xvii. pp. 173–184, pl. 13 and 14).

In his first notice of the disease the Rev. M. J. Berkeley speaks of it as a "minute fungus which has caused some consternation amongst the coffee planters of Ceylon in consequence of the rapid progress it seems to be making amongst the coffee plants." He further remarks: "It is not only quite new, but with difficulty referable to any recognised section of fungi. Indeed, it seems just intermediate between true mould and Uredos, allied on the one hand to *Trichobasis*, and on the other to *Rhinotrichum*. Though the fungus is developed from the parenchyma of the leaf, there is not any covering to the little heaps, such as is so obvious in *Uredo* and its immediate allies, while the mode of attachment reminds one of *Rhinotrichum*." At that time no other form of *Hemileia* was known, and it was supposed to stand alone as the only species, and to be indigenous to Ceylon. Since then, another species of *Hemileia*, viz., *H. canthii*, B. and Br., has been found on a Ceylon jungle tree, *Canthium campanulatum*,[1] and lately Dr. Cooke appears to have met with a third species from Southern Africa.

Writing in 1874, Dr. Thwaites, the distinguished Director of the Botanic Gardens, Ceylon, describes the *Hemeleia vastatrix* as "a parasitic growth within the coffee tree of a well-defined species of fungus, originated and reproduced by means of spores, easily distinguished from every other known fungus." "There can be no question," he continues, "that this fungus is communicated from coffee plant to coffee plant through the dissemination of its spores, and that these may be conveyed by the wind, or by streams of water, or by animals of any kind moving from place to place." Though at first it was believed that some elements of the fungus were present "in the growing tissues of the coffee plant in a *diffused form*," this view was afterwards abandoned, further microscopical investigations having proved that the disease was mainly external, and "that the coffee tree suffered rather from exhaustion than from the poisoning of its juices." During 1873 and 1874 investigations of an important character were carried on by Dr. Thwaites and the Rev. R. Abbay, which led them to the conclusion that when grown upon charcoal kept constantly moist, the orange-coloured spores representing the fruit of the disease, gave rise to filaments more or less branched. At the termination of the branches "*secondary spores* appear to have been produced in the form of radiating necklace-shaped strings of little spherical bodies of uniform size, closely resembling the fructification of an *Aspergillus*."

2. *Effects produced.*—The effects of the fungus upon the coffee trees would seem to be the gradual loss of vital energy caused by repeated destruction of the leaves. The tree after the first attack of the disease, which is often apparently the most severe, throws out fresh, healthy-looking leaves, and exhibits for a certain period the appearance of having perfectly recovered. These fresh leaves, however, after the expiration of a few months, exhibit the characteristic spotting, and are sooner or later covered, on the under side, by orange-coloured dust representing the spores of the disease, and, as in the previous attack, fall prematurely. These repeated attacks at length seriously affect the health of the tree, which, if old and ill-cultivated, becomes of little or no value as a crop-producer.

The rapidity with which the disease was propagated after its first appearance, may be realised from the fact that although it was noticed only in one locality in May, 1869, it quickly spread to the neighbouring coffee-districts, and especially among native coffee, till in 1873 it was spoken of "as being found in nearly all, if not all, the estates in the island." The disease appears to have been noticed in India in 1869 and 1870, almost simultaneously with its appearance in Ceylon.[2] In February, 1874, its presence was seriously felt in Tellicherry, and it appears to have spread generally through the Wynaad and Mysore districts, and its first effects were so severe that it threatened to give a considerable check to coffee enterprise in Southern India.[3] In 1876 the disease appeared in Sumatra, and this year it has been found in the plantations of Java and Bencoolen; there can be little doubt, therefore, that the *Hemileia* is destined to be a wide-spreading and prevalent enemy in all coffee-producing areas of the East Indies.

The effects of the leaf-disease upon the exportation of

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[1] "Enum. Plant. Zeylan. Rubiaceæ," p. 153.

[2] Report of India Museum, M. C. Cooke, 1876.

[3] *Gardener's Chronicle*, February, 1874.